CONTINUATION-IN-PART

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THERMALLY DEVELOPABLE IMAGING MATERIAL

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THERMALLY DEVELOPABLE IMAGING MATERIAL

This application is a Continuation-in-part of commonly assigned and copending patent application U.S. Serial No. 10/789,740, filed on February 27, 2004, in the names of Vanous et al.

FIELD OF THE INVENTION

The invention relates generally to the field of thermally developable imaging materials such as thermographic and photothermographic materials.

BACKGROUND OF THE INVENTION

Silver-containing photothermographic imaging materials that are developed with heat and without liquid development have been known in the art for many years. Such materials are used in a recording process wherein an image is formed by imagewise exposure of the photothermographic material to specific electromagnetic radiation (for example, visible, ultraviolet or infrared radiation) and developed by the use of thermal energy.

These materials, also known as "dry silver" materials, generally comprise a support having coated thereon: (a) photosensitive catalyst (such as silver halide) that upon such exposure provides a latent image in exposed grains that is capable of acting as a catalyst for the subsequent formation of a silver image in a development step, (b) a non-photosensitive source of reducible silver ions, (c) a reducing composition (usually including a developer) for the reducible silver ions, and (d) a hydrophilic or hydrophobic binder. The latent image is then developed by application of thermal energy.

The imaging arts have long recognized that the field of photo-thermography is distinct from that of photography. Photothermographic materials differ significantly from conventional silver halide photographic materials that require processing with aqueous processing solutions.

For example, in photothermographic imaging materials, a visible image is created by heat as a result of the reaction of a developer incorporated within the material. In contrast, conventional photographic imaging materials require processing in aqueous processing baths at moderate temperatures to provide a visible image.

In photothermographic materials, a small amount of silver halide is used to capture light and a non-photosensitive source of reducible silver ions (for example, a silver carboxylate) is used to generate the visible image using thermal development. Thus, the imaged photosensitive silver halide serves as a catalyst for the physical development process involving the non-photosensitive source of reducible silver ions and the incorporated reducing agent. In contrast, conventional wet-processed, black-and-white photographic materials use only one form of silver (that is, silver halide) that, upon chemical development, is itself converted into the silver image, or that upon physical development requires addition of an external silver source (or other reducible metal ions that form black images upon reduction to the corresponding metal). Thus, photothermographic materials require an amount of silver halide per unit area that is only a fraction of that used in conventional wet-processed photographic materials.

U.S. Patent No. 6,582,892 (Kong), commonly assigned and incorporated herein by reference, describes a heat-stabilized thermally developable imaging material. As disclosed in U.S. Patent No. 6,582,892, photothermographic materials can be used, for example, in conventional black-and-white photothermography, in electronically generated black-and-white hardcopy recording. They can be used in microfilm applications, in radiographic imaging (for example, digital medical imaging), and industrial radiography. The absorbance of these photothermographic materials between 350 and 450 nm is desirably low (less than 0.5), to permit their use in the graphic arts area (for example, imagesetting and phototypesetting), and in proofing. Thermally developable materials have gained widespread use in several industries, particularly in radiography. Thus, photothermographic materials are useful for medical radiography to provide black-and-white images.

Such photothermographic materials can be sensitive to radiation at a wavelength of at least 700 nm, and at a wavelength of from about 750 to about 1400 nm.

Silver-containing direct thermographic imaging materials are non-photosensitive materials that are used in a recording process wherein images are generated by the direct application of thermal energy. These well known materials generally comprise a support having disposed thereon one or more imaging layers comprising (a) a relatively or completely non-photosensitive source of reducible silver ions, (b) a reducing agent composition (acting as a developer) for the reducible silver ions, and (c) a suitable hydrophilic or hydrophobic binder. Thermographic materials are sometimes called "direct thermal" materials in the art because they are directly imaged by a source of thermal energy without any transfer of the energy or image to another material.

In a typical thermographic construction, the image-forming layers are based on silver salts of long chain fatty acids. The preferred non-photosensitive reducible silver source is a silver salt of a long chain aliphatic carboxylic acid having from 10 to 30 carbon atoms, such as behenic acid or mixtures of acids of similar molecular weight. At elevated temperatures, the silver of the silver carboxylate is reduced by a reducing agent whereby a black-and-white image of elemental silver is formed.

Direct thermographic materials are imaged by contact with a thermal printhead of a thermographic recording apparatus such as a thermal printer or thermal facsimile. In such materials, the thermographic material is imaged at an elevated temperature, typically in the range of from about 300 to about 400°C for 50 ms or less, to form a visible image, for example as described in U.S. Patent No. 5,759,953 (Defieuw et al.), incorporated herein by reference.

It is noted that, when thermographic materials are imaged, both imaging and processing occur substantially simultaneously. Accordingly, the terms thermally imaging, processing, and developing, might be employed interchangeably when used to describe the field of thermography.

Thermographic and photothermographic materials are processed in a thermal processor that employs heat to develop the material to generate a developed image. While both types of materials have been well received in the industry, there continues a need to improve the characteristics of thermographic and photothermographic materials, such that when processed, a high quality processed image is provided.

SUMMARY OF THE INVENTION

An object of the present invention is to provide thermographic and photothermographic materials having improved characteristics when thermally processed.

Another object of the present invention is to provide such materials that, when thermally processed, comprise an area of mid-range density along one edge of the material.

These objects are given only by way of illustrative example, and such objects may be exemplary of one or more embodiments of the invention. Other desirable objectives and advantages inherently achieved by the disclosed invention may occur or become apparent to those skilled in the art. The invention is defined by the appended claims.

According to one aspect of the invention, there is provided a thermographic or a photothermographic material having a D_{min} and D_{max} optical density. The material includes a support having thereon one or more thermally-developable imaging layers which are developable to produce an image when the thermographic or photothermographic material is thermally processed. The material further includes an area disposed along a length of at least one edge of the thermographic or photothermographic material, the area having an optical density less than the D_{max} and greater than the D_{min} of the material.

According to another aspect of the invention, there is provided a method of thermally processing a photothermographic material comprising a support having thereon one or more thermally-developable imaging layers.

The method comprises the steps of: exposing an area along at least one edge of the photothermographic material such that, when thermally processed by a thermal processor, the image density of the area will be less than a Dmax and greater than a Dmin of the photothermographic material; and providing means to transport the photothermographic material to the thermal processor such that the edge is first transported through the thermal processor.

According to yet a further aspect of the invention, there is provided a method of forming a visible image. The method comprises the steps of: exposing a first area of a photothermographic material to form a latent image, the photothermographic material comprising a support having thereon one or more thermally-developable imaging layers which are developed when the photothermographic material is thermally processed; exposing a second area, different than the first area, of the photothermographic material disposed along a leading edge of the photothermographic material such that, when developed, the second area has an image density less that the Dmax and greater than the Dmin of the photothermographic material; transporting the photothermographic material to a thermal processor such that the leading edge first contacts the thermal processor; and thermally processing the first and second areas to develop the visible image.

According to another aspect of the invention, there is provided a method of thermally processing, in a thermographic imaging apparatus, a thermographic material comprising a support having thereon one or more thermally-developable imaging layers.

The method comprises the steps of: thermally processing an area along at least one edge of the thermographic material such that the image density of the area will be less than a Dmax and greater than a Dmin of the thermographic material; and providing means to transport the thermographic material through the thermographic imaging apparatus such that the edge is first transported through the thermographic imaging apparatus.

According to yet a further aspect of the invention, there is provided a method of forming a visible image using a thermographic imaging apparatus. The method comprises the steps of: thermally imaging a first area of a thermo-

graphic material comprising a support having thereon one or more thermally-developable imaging layers which are developed when the thermographic material is thermally processed; thermally processing a second area, different than the first area, of the thermographic material disposed along a leading edge of the thermographic material such that, when developed, the second area has an image density less that the D_{max} and greater than the D_{min} of the thermographic material; whereby the leading edge first contacts the thermographic imaging apparatus; and thermally processing the first and second areas to develop the visible image.

In yet another aspect of the invention, the method comprises the steps of thermally imaging a third area, different from the first and second areas, of the thermographic material disposed along a side edge of the thermographic material such that, when heated, the third area has an image density of about D_{max} of the thermographic material.

Where the thermographic and photothermographic materials comprise a transparent support, the method can further comprise: positioning the thermally processed material with the visible image thereon between a source of imaging radiation and an imageable material that is sensitive to the imaging radiation, and thereafter exposing the imageable material to the imaging radiation through the visible image in the imaged thermographic or photothermographic material to provide an image in the imageable material.

The method of this invention can be used to provide an imaged thermographic material or a photothermographic material to be used for medical diagnostic purposes.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features, and advantages of the invention will be apparent from the following more particular description of the preferred embodiments of the invention, as illustrated in the accompanying drawings.

FIG. 1 shows a diagrammatic view of a laser imaging system suitable for thermally processing a photothermographic material in accordance with the present invention.

FIG. 2 shows a prior art thermally processed photothermographic material.

FIG. 3 shows a thermally processed photothermographic material in accordance with the present invention.

FIG. 4a shows a diagrammatic view of the photothermographic material in accordance with the present invention.

FIG. 4b shows an enlarged/exaggerated view of the diagrammatic view of FIG. 4a.

FIG. 5 shows an example of a half-tone suitable for the present invention.

FIG. 6 shows a diagrammatic view of a thermographic imaging apparatus suitable for thermally imaging a thermographic material in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The following is a detailed description of the preferred thermographic and/or photothermographic embodiments of the invention. Particular reference is made to the drawings in which the same reference numerals identify the same elements of structure in each of the several figures.

As used herein, "photothermographic material(s)" means a construction comprising at least one photothermographic emulsion layer or a photothermographic set of layers (wherein the silver halide and the source of reducible silver ions are in one layer and the other essential components or desirable additives are distributed, as desired, in an adjacent coating layer) and any supports, topcoat layers, image-receiving layers, blocking layers, antihalation layers, subbing or priming layers. These materials also include multilayer constructions in which one or more imaging components are in different layers, but are in "reactive association" so that they readily come into contact with each

other during imaging and/or development. For example, one layer can include the non-photosensitive source of reducible silver ions and another layer can include the reducing composition, but the two reactive components are in reactive association with each other.

As used herein, sensitometric terms "photospeed" or "photographic speed" (also known as "sensitivity"), and "contrast" have conventional definitions known in the imaging arts.

As used herein, "thermographic material(s)" means a construction comprising at least one thermographic emulsion layer or thermally sensitive imaging layer(s) wherein the source of reducible silver ions is in one layer and the other essential components or desirable additives are distributed, as desired, in the same layer or in an adjacent coating layer, as well as any supports, topcoat layers, image-receiving layers, carrier layers, blocking layers, conductive layers, subbing or priming layers. These materials have at least one protective layer as described herein. These materials also include multilayer constructions in which one or more imaging components are in different layers, but are in "reactive association." For example, one layer can include the non-photosensitive source of reducible silver ions and another layer can include the reducing agent, but the two reactive components are in reactive association with each other. Such embodiments also include an outermost protective layer over all thermally sensitive layers.

When used in thermography, the term, "imagewise exposing" or "imagewise exposure" means that the material is imaged using any means that provides an image using heat. This includes, for example, analog exposure where an image is formed by differential contact heating through a mask using a thermal blanket or infrared heat source, as well as by digital exposure where the image is formed one pixel at a time such as by modulation of thermal printheads or by thermally imaging with a scanning laser beam.

The preferred thermographic materials for employment with this invention are "direct" thermographic materials and thermal imaging is carried out in a single thermographic material containing all of the necessary imaging chemistry. In direct thermographic materials, imaging, development, and

processing occur at the same time and the terms are synonymous. Direct thermal imaging is distinguishable from what is known in the art as thermal transfer imaging (such as dye transfer imaging) in which the image is produced in one material ("donor") and transferred to another material ("receiver") using thermal means.

"Emulsion layer," "imaging layer," or "thermographic emulsion layer," means a thermally sensitive layer of a thermographic material that contains the non-photosensitive source of reducible silver ions. It can also mean a layer of the thermographic material that contains, in addition to the non-photosensitive source of reducible ions, additional desirable components. These layers are usually on what is known as the "frontside" of the support.

The protective layer is the outermost layer on the imaging side of the material that is in direct contact with the imaging means.

"Non-photosensitive" means not intentionally light sensitive. The direct thermographic materials of the present invention are non-photosensitive meaning that no photosensitive silver halide(s) has been purposely added.

Transparent means capable of transmitting visible light or imaging radiation without appreciable scattering or absorption.

The terms "double-sided," "double-faced coating," and "duplitized" are used to define thermographic and/or photothermographic materials having one or more of the same or different thermally sensitive layers disposed on both sides (frontside and backside) of the support.

The sensitometric terms "D_{min}" and "D_{max}" have conventional definitions known in the imaging arts. In photo-thermo-graphic materials, D_{min} is considered herein as image density achieved when the photo-thermo-graphic material is thermally developed without prior exposure to radiation. It is the average of eight lowest density values on the exposed side of the fiducial mark.

In thermographic materials, D_{min} is considered herein as image density in the areas with the minimum application of heat by the thermal printhead or other thermal applicator of a thermographic imaging apparatus.

In photothermographic materials, the term D_{max} is the maximum image density achieved when the photothermographic material is exposed to a particular radiation source and then thermally developed.

In thermographic materials, the term D_{max} is the maximum image density achieved when the thermographic material is thermally developed.

The terms "density," "optical density (OD)," and "image density" refer to the sensitometric term absorbance.

It is noted that not every/all medical images include/show/exhibit regions of D_{min} and D_{max}. D_{min} and D_{max} are inherent characteristics of the material; the thermographic and photothermographic material is characterized by D_{min} and D_{max} optical density parameters.

Further, the density term "mid-tone" or "mid tone density" refers to optical densities of the image in the middle of the dynamic range of the thermographic or photothermographic material.

Photothermographic material, also referred to as film, media, element, or sheet, is processed in a thermal processor that employs heat to develop the material. One type of thermal processor uses a heated drum for developing an exposed material brought into contact with the drum. Another type of thermal processor uses a flat bed processor for developing the exposed material. For example, U.S. Patent No. 5,953,039 (Boutet) and U.S. Patent No. 6,114,660 (Donaldson), both commonly assigned and incorporated herein by reference, disclose photothermographic processors suitable for developing photothermographic material. Other types of thermal processors may be known to those skilled in the art.

Figure 1 shows an exemplary laser imaging apparatus 10. Apparatus 10 includes a laser printer 12 and thermal processor 14. Although printer 12 and thermal processor 14 are shown as housed in separate units, it will be understood that they could be integrated into one housing. In the specific application described herein, printer 12 is a medical image laser printer for printing medical images on photothermographic film which is thermally processed by thermal processor 14. The medical images printed by printer 12 can be derived

from medical image sources, such as medical image diagnostic scanners (MRI, CT, US, PET), direct digital radiography, computed radiography, digitized medical image media (film, paper), archived medical images, and the like.

Printer 12 includes printer housing 13, laser scanner 16, supplies 18, 20 for unexposed photothermographic film 22, a scan drum 24, film path 26, control 28, memory 30, printer/processor film interface 32. Processor 14 includes processor housing 15, interface 32, drum 34 heated by lamp 36, hold-down rollers 38 located around a segment of the periphery of drum 34, exposed film cooling assembly 40, densitometer 42, and output tray 46.

Apparatus 10 operates in general as follows. A medical image stored in memory 30 modulates the laser beam produced by the laser of scanner 16. The modulated laser beam is repetitively scanned in a fast or line scan direction to expose photothermographic film 22. Film 22 is moved in a slow or page scan direction by slow scan drum 24 which rotates in the direction of arrow 44. Unexposed photothermographic film 22, located in supplies 18,20, is moved along film path 26 to slow scan drum 24. A medical image is raster scanned onto film 22 through the cooperative operation of scanner 16 and drum 24.

After film 22 has been exposed, it is transported along path 26 to processor 14 by printer/processor film interface 32. The exposed film 22 is developed by passing it over heated drum 34 to which it is held by rollers 38. After development, the film 22 is cooled in film cooling assembly 40. Densitometer 42 reads the density of control patches at the front edge of film 22 to maintain calibration of the laser imaging apparatus 10. The cooled film 22 is transported to tray 46 where it can be removed by a user.

As discussed above, photothermographic film includes a photothermographic emulsion on one side or two sides of a support. Cooling of the film provides good adhesion characteristics between the emulsion and the support. However, if the heated film is not sufficiently cooled prior to coming into contact (including sliding and rubbing contact) with another entity (for example, a guide or blade) as the film leaves drum 34, the emulsion might be marred or "peeled"

away from the support, potentially leaving an aesthetically undesirable "ragged" edge.

To reduce/eliminate such an occurrence, existing films include a leading edge having an area having a clear/transparent D_{min}. Figure 2 shows an exemplary prior art film 22 having a leading edge 50 comprising an area 52 of D_{min}. Described alternatively, the border of the leading edge of the film is clear/transparent. As shown, D_{min} area 52 is a strip disposed along the length of leading edge 50. Typically, the width of D_{min} area 52 is in the order of about 0.2mm to about 10mm. Such an area is employed since the adhesion properties/characteristics of the processed emulsion to the support are more aggressive at a density of D_{min} than at a density of D_{max}. Therefore, by providing a D_{min} area at leading edge 50 of film 22, any emulsion peel-back is avoided/reduced as the hot film leaves the heated drum.

However, the clear/transparent strip/edge of film 22 will allow light to pass through when placed on a light box. Such an emission of light can be an annoyance/distraction to a radiologist as they read the printed image. The clear/transparent leading edge can be particularly distracting if one or more other edges/borders of the film have a value of D_{max}.

The present invention addresses the problem noted above. More particularly, the present invention provides a film having a non-D_{min} area disposed at its leading edge.

The present invention provides photothermographic materials comprising an area, adjacent a leading edge, having an image density intermediate D_{min} and D_{max}. More particularly, the area comprises a mid-density range (or mid-range density). That is, having a density in the range of about 0.5 to about 2.5 optical density (OD). In a preferred embodiment, the density is at least about 1.2 to about 2.5 optical density (OD). In a preferred embodiment, mid-density range is not greater than about 2.5 optical density.

D_{max} can be in the range of from about 2.4 to about 3.6 optical density. Though some materials have a D_{max} greater than 3.6 OD, for example, a

Dmax of 4.0 OD or greater. The mid-density range can be between about 20 percent to about 80 percent of Dmax of the material.

Applicants have recognized that providing such a non-Dmin area adjacent the leading edge of the film improves the "readability" and aesthetic qualities of the film. More particularly, Applicants have noticed that imaging the leading edge to a mid-density reduces/minimizes the annoyance/distraction effects which occur with a clear/transparent edge.

For example, if the leading edge is at Dmin and another edge is at a Dmax of 3.1 optical density, the leading edge is obvious and undesirable. In contrast, if the leading edge is at a mid-density of about 1.8 optical density and another edge is at a Dmax of 3.1 optical density, the leading edge is not readily noticed.

Figure 3 shows a thermally processed photothermographic material in accordance with the present invention. As shown, film 22 has a leading edge 60 comprising an area 62 of mid-density range (which can be denoted as Dmid). As shown, area 62 is not readily distinguishable from an area 64 disposed along another edge 66, wherein area 64 has a density of Dmax.

Figures 4a and 4b are provided to more generally illustrate the regions/areas illustrated in Figure 3. As shown, Figure 4 shows a plurality of regions/areas of a portion of film 22. Film 22 includes a leading edge 70 and a first region 72 disposed along the length of leading edge 70 proximate leading edge 70. A second region 74 is disposed along another edge 76 adjacent edge 76. A third region 78 is disposed inboard of leading edge and other edge 76 and is representative of the imaging area of film 22.

First region 72 is the area of Dmid (i.e., mid-range density), as described above, thus corresponding with area 62 of Figure 3. Second region 74 is the area wherein a density of Dmax is typically employed (or typically a density in the range of Dmax), thus corresponding with area 64 of Figure 3.

As indicated above with regard to the prior art, the width of Dmin area 52 (shown in Figure 2) is in the order of about 0.2mm to about 10mm. In the present invention, as best illustrated in Figure 4b, a width W3 of first region 72

(i.e., the area having mid-density range) can range up to 25mm from edge 70. Preferably, area 72 is disposed as close to leading edge 70 as possible, that is, that a width/dimension W1 is minimal/minimized. Starting first region 72 about 0.1mm (i.e., a W1 of 0.1mm) inboard of (i.e., spaced from) edge 70 has been found to be suitable for Applicants' application, as has starting about 0.2-0.5mm (W1) inboard of edge 70. As such, a width W2 (i.e., W3-W1) of first region 72 can range from about 0.1mm to about 25mm.

Applicants have determined that the adhesion characteristics of the processed emulsion are sufficient at mid-density for Applicants' application, that is, to minimize peel back so as to provide an acceptable/suitable processed image. In another embodiment, region 72 adjacent leading edge 70 is comprised of a half-tone style image. That is, region 72 comprises a pattern to give a mid-range density appearance. An example is shown in Figure 5, wherein a plurality of small/tiny dots/circles of D_{min} and D_{max} provide the area with a mid-density appearance. Those skilled in the art may recognize other patterns to provide a similar appearance. Such an embodiment would reduce/minimize the area of high density exposure – thereby resulting in a mid-density appearance – yet, provide areas of D_{min} to "tack down" the emulsion to the support.

In a further embodiment, region 72 may comprise a gradient optical density having a first, lower density at the edge (for example, a density of 1.0 OD) which increases to a higher density (i.e., toward D_{max}) over a dimension of approximately 0.1mm-0.5mm. Such an increase in density can be linear, exponential, or the like.

While the present invention has been described above with reference to photothermographic materials, the present invention can also be employed using thermographic materials. Accordingly, the thermographic material – like the photothermographic material - comprises an area, adjacent a leading edge, having an image density intermediate D_{min} and D_{max}, and the above description is applicable to thermographic materials.

Figure 6 shows an exemplary thermographic imaging apparatus 80. Apparatus 80 includes a thermal printer 82. For the particular application

described herein, thermal printer 82 is a medical image thermal printer for printing medical images on thermographic film that is thermally processed. The medical images printed by thermal printer 82 can be derived from medical image sources, such as medical image diagnostic scanners (MRI, CT, US, PET), direct digital radiography, computed radiography, digitized medical image media (film, paper), archived medical images, and the like.

Thermal printer 82 can include a printer housing 84, a thermal imager 86, supply trays 88, 90 for supporting a supply of thermographic film 92, a transport roller 94, a film path 96, a controller 100, a memory 102, a heating station 104, a densitometer 106, and an output tray 108. Thermal imager 86 can be any source of thermal energy that can be modulated to produce an image, such as a thermal printhead array or a high intensity laser. Figure 6 illustrates imager 86 as a thermal laser.

Thermographic imaging apparatus 80 operates in general as follows. A medical image stored in memory 102 modulates thermal imager 86. Thermal imager 86 imagewise heats thermographic film 92 to form an image on the film. Unimaged (also referred to as unexposed) thermographic film 92, located in supply trays 88, 90, is moved along film path 96 to thermal imager 86. To form an image on the film, thermographic film 92 is moved in a slow or page scan direction by transport roller 94 which rotates in the direction of arrow 98. A medical image is thermally imaged onto film 92 through the cooperative operation of thermal imager 86 and transport roller 94.

The imaged film 92 is then heated in heating station 104. Imaged film 92 is transported to tray 108 where it can be removed by a user. Densitometer 106 can be employed to read the density of a control patch(es) disposed at the front edge of film 92 to maintain calibration of the thermographic imaging apparatus 80.

In thermographic and photothermographic materials, a photocatalyst (such as photosensitive silver halide when used in photothermographic materials), a non-photo-sensitive source of reducible silver ions, a

reducing agent composition, and any other additives used in the present invention are generally added to one or more binders.

When a silver benzotriazole non-photo-sensitive source of reducible silver ions is used in a photothermographic material, preferred reducing agents are ascorbic acid compounds. When a silver carboxylate silver non-photo-sensitive silver source is used in a photothermographic material, preferred reducing agents are bis-hindered phenol compounds. When a silver carboxylate non-photosensitive silver source is used in a thermographic material, preferred reducing agents are aromatic di- and tri-hydroxy compounds having at least two hydroxy groups in *ortho-* or *para-*relationship on the same aromatic nucleus.

Suitable binders include polyvinyl butyral resins for an imaging layer, and cellulose acetate butyrate resins for a protective overcoat or topcoat layer. Mixtures of binders can also be used. An acrylic or methacrylic acid ester polymer, such as poly-methylmethacrylate can be mixed with cellulose acetate butyrate, for example, in an amount of at least 5% by weight of the total overcoat binder, to promote adhesion of an overcoat to an imaging layer.

Hardeners for various binders may be present. Useful hardeners are well known and include diisocyanate compounds as described for example, in EP-0 600 586B1 and vinyl sulfone compounds as described in EP-0 600 589B1. One useful hardener is DESMODUR® N3300, a trimeric aliphatic hexamethylene diisocyanate available from Bayer Chemicals (Pittsburgh, PA). The amount of isocyanate in the protective overcoat is at least 1% by weight of the binder, and preferably at least 5% of the overcoat binder. The amount of isocyanate in the imaging layer is at least 0.5% by weight of the binder, and preferably at least 2% of the imaging layer binder.

The invention has been described in detail with particular reference to a presently preferred embodiment, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention. The presently disclosed embodiments are therefore considered in all respects to be illustrative and not restrictive. The scope of the invention is indicated by the

appended claims, and all changes that come within the meaning and range of equivalents thereof are intended to be embraced therein.

PARTS LIST

10	laser imaging apparatus
12	printer
13	printer housing
14	thermal processor
16	laser scanner
18, 20	supplies
22	photothermographic film
24	scan drum
26	film path
28	control
30	memory
32	printer/processor film interface
34	drum
36	lamp
38	hold-down rollers
40	exposed film cooling assembly
42	densitometer
44	arrow
46	output tray
50	leading edge
52	D_{min} area
60	leading edge
62	area
64	area
66	edge
70	leading edge
72	first region
74	second region
76	edge
78	third region

80	thermographic imaging apparatus
82	thermal printer
84	printer housing
86	thermal imager
88	supply tray
90	supply tray
92	thermographic film
94	transport roller
96	film path
98	arrow
100	controller
102	memory
104	heating station
106	densitometer
108	output tray